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Can specializing in Family Medicine reduce Hospitalization for Ambulatory Care Sensitive Conditions? Evidence from a cross-sectional ecological study.

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Descriptors: PRIMARY HEALTH CARE, GENERAL PRACTICE, PUBLIC HEALTH, OUTCOME RESEARCH EVALUATION.

ABSTRACT: **Introduction:** Hospitalization for ambulatory care sensitive conditions (HACSCs) is frequently used as an indicator of the quality and effectiveness of primary health care (PHC) services around the world. The aim of the present study was to evaluate whether the PHC model (Family Health Strategy-FHS- x conventional) and the availability of specialized PHC physicians is associated or not with total hospitalization or HASSCs in the National Health System (SUS) of the municipality of Curitiba, Paraná state (PR). **Methodology:** this is a cross-sectional ecological study using multiple linear regression with socioeconomic and professional data from Municipal Health Units (MHU) between April 1, 2014 and March 31, 2015. **Results:** after adjustment for age and sex and control of socioeconomic variables, the FHS model was associated with six fewer HACSCs a year per 10,000 inhabitants in relation to the conventional model and the availability of one family physician (FP) at an FHS model MHU per 10,000 inhabitants was associated with 1.1 fewer HACSCs for heart failure (HF) a year per 10,000 inhabitants; both results were statistically significant at 5%. Basic specialists (clinicians, pediatricians and obstetrician/gynecologists) and subspecialists showed no significant association with HACSC rates. **Conclusion:** these results obtained in a major Brazilian city reinforce the role of FHS as a priority PHC model in the country and indicate the potentially significant impact of specializing in family medicine on improving the health conditions of the population.

STRENGTHS AND LIMITATIONS OF THIS STUDY: All public PHC services in a major Brazilian city were included in this study and its results were adjusted for the most important socioeconomic variables, whose influence is well recognized in hospitalizations. However, the short period of PHC physicians' presence in MHUs considered (12 months), the small number of MHUs studied and the impossibility of controlling the results for other potential confounding variables justify caution in the interpretation of these results, which should be confirmed by new studies.

What is already known on this subject?

- Effective and quality primary health care (PHC) is related to fewer Hospitalizations for Ambulatory Care Sensitive Conditions (HACSCs) worldwide.
- In Brazil, the family health strategy (FHS), a priority PHC organization strategy in the country, has also been associated with fewer HACSCs.
- There was a significant association between specializing in family medicine and the strength of PHC attributes among FHS doctors in Brazil.

How does this study contribute?

- Specializing in family medicine in PHC was significantly associated with lower HACSC rates, especially due to heart failure.
- No other PHC medical specialties were significantly associated with HACSC rates.

INTRODUCTION:

Primary health care (PHC) is the first-contact level and the backbone of rational National Health Systems, responsible for providing accessible, continuous, comprehensive and coordinated health care to the population.(1) An important indicator of the quality and effectiveness of this care is the rate of hospitalizations for ambulatory care sensitive conditions (ACSC).(2-5) ACSCs are conditions that can be controlled through the provision of timely and qualified PHC services to avoid hospitalization by 1) preventing the onset of disease, 2) adequately controlling acute illness or 3) effectively managing chronic conditions.(6) Brazil has had a National ACSC List since 2008.(7,8)

In Brazil, the preferred PHC organization model within the National Health System (SUS) is the Family Health Strategy (FHS).(9) FHS teams consist of a general practitioner, a professional nurse, one or two assistant nurses and 4 to 12 community health agents, caring for 3000 people on average.(9) Nevertheless, the so-called conventional model, based on ambulatory care in the basic specialties of Pediatrics, Internal Medicine and Gynecology and Obstetrics persists, particularly in large cities.(10,11) PHC physicians are not legally required to have a specialty. Physicians become specialists in Family Medicine in Brazil after completing two-year Medical Residency program or through a certification examination after 4 years' experience in the field.

Several studies have demonstrated an association between FHS coverage and a decline in HACSCs.(12-15) Between 1999 and 2007, chronic HACSC rates in municipalities with greater FHS coverage were 13% lower in relation to those with less coverage, reaching 23% for hospitalization due to asthma.(16)

A recent study found a significant association between specializing in family medicine and the strength of PHC attributes in the FHS of an important Brazilian capital, measured using the PCA-tool.(17) Thus, it can be speculated that specific medical training for PHC in Brazil is related to both major and intermediate health outcomes. If lower HACSC rates are expected with access to qualified clinical care, medical specialties aimed at training PHC professionals should, in theory, influence this outcome. However, studies that assess the relationship between the specialties of PHC physicians and health outcomes remain scarce.

The aim of the present study was to evaluate whether the PHC model and the availability of specialized PHC physicians are associated or not with total hospitalization or HASSC rates in the National Health System (SUS) of the municipality of Curitiba, Paraná state (PR).

METHODOLOGY:

This is a cross-sectional ecological study conducted in the municipality of Curitiba (PR). The municipality exhibits high PHC coverage, particularly in terms of FHS, which reached 52% of the population in April 2014.(18) Moreover, a high number of family physicians is reported in comparison to other Brazilian capitals, and health care services have been computerized for over a decade.(10) The units of analysis were Municipal Health Units (MHU), classified as a Family Health Strategy (FHS) or Conventional (EAB) in accordance with the PHC model of their teams.

Data:

Socioeconomic data by census tract were obtained from 2010 Census databases, provided by the Brazilian Institute of Geography and Statistics (IBGE).

Information on hospital admissions was obtained from the Hospital Information System (SIH), through registered Hospitalization Authorization Forms (AIH). Inclusion criteria were single or initial AIH, valid until June 2015, for Curitiba (PR) residents hospitalized in the municipality between April 1, 2014 and March 31, 2015. Hospital admissions for childbirth (International Classification of Diseases, 10th edition - ICD-10 - O.80 to O.84) were excluded as physiological events.(7)

AIH information and socioeconomic data were aggregated at the level of the Municipal Health Unit (MHU) coverage areas, using QuantumGIS software, version 2.10 Pisa. Addresses on AIH were geocoded using the MMQGIS plugin and GoogleMaps server.

Quantitative data and information on the specialties of PHC physicians in Curitiba (PR) during the study period were obtained from databases of the Curitiba Municipal Health Department (SMS-Curitiba), Regional Board of Medicine for the State of Paraná, Brazilian Medical Association (AMB), and the National Medical Residency Committee (CNRM).

The MHU model and doctors' working hours were used as predictor variables. Doctors were classified as 1) Family Physicians (FP); 2) Basic Specialty Physicians (BSP); or 3) Subspecialty Physicians (SUBP) if they had concluded their medical residency through the CNRM or been awarded a degree by a scientific association recognized by the AMB prior to May 31, 2015, in the fields of 1) Family Medicine (FM); 2) Internal Medicine, Pediatrics or Gynecology and Obstetrics; and 3) other Medical Specialties, respectively.

The average supply of doctors was calculated using the mean total working hours of physicians in each MHU during the study period. For physicians who remained at the same MHU for the 12-month study period, total effective working hours were added to working hours per category for each MHU, according to the classification above. For each amount, the ratio of working hours to the total population residing in the MHU coverage area (2010 Census) was calculated. In order to facilitate understanding, variables were presented as "number equivalent to physicians with a 40-hour work week per 10,000 inhabitants" ("Equivalents").

As outcome variables for each MHU, total hospitalization rates were calculated, as well as HACSC and the main ACSC per age group, namely bacterial pneumonia (BP), angina and heart failure (HF). Hospitalization rates were standardized for age and sex via the direct method, using the structure of the population of Curitiba (PR) according to the 2010 Census as reference. In order to calculate hospitalization rates, the population in the respective MHU coverage areas was used as a denominator, in accordance with the 2010 Census. Hospitalizations for ACSC (HACSC) were defined as those for which the "Main Diagnosis" field of the AIH contained a disease classified by an ICD-10 code as belonging to the Brazilian List of Ambulatory Care Sensitive Conditions.(8) Due to its high incidence rate, records for which the main diagnosis was ICD-10 J18.9 (Pneumonia; unspecified organism) were included in this study as BP.

Four socioeconomic variables per MHU were adopted as context: 1) literacy rate in the population aged 10 years or older (Lit.Rt); 2) percentage of blacks, mulattos and native Brazilians (Pop.Perc); 3) Per capita income (Income); and 4) percentage of households with a per capita income below half the minimum wage (Perc.House).

Data analysis:

SPSS Statistics software version 18 (PASW Statistics 18) was used for data analysis. Calculation of the variance inflation factor (VIF) identified high collinearity (VIF>5) between the socioeconomic variables Lit.Rt, Pop.Perc and Perc.House, preventing their concomitant use in the analysis, but not between variables related to physician working hours. Working hours per medical category were similar between EAB and FHS model MHUs, except for FP, whose working hours were 15 times higher at FHS model MHUs than conventional (EAB) units.

In order to estimate the effects of predictor variables independently of socioeconomic variables, hierarchical linear regression with stepwise-backward elimination was carried out for each dependent variable studied, with an F-to-enter statistic of 0.10 and F-to-remove of 0.20, initially for all the MHUs and subsequently for FHS model MHUs. The variable related to the FP category was only used in the latter given its significant association with this model.

Two models were constructed. Model 1 included the variable “Income” and, among the socioeconomic variables exhibiting high collinearity, the variable with the greatest Beta value in simple regression for the dependent variable under study. Variables with a p-value lower than 0.20 were maintained and fixed for model 2, which included the other variables under study. The results were presented as non-standardized coefficients and considered significant at 5%. Results significant at 10% were identified for HACSCs.

RESULTS:

The study included 109 MHUs, 44 (40.4%) of which were conventional (EAB) and 65 (59.6%) applied the FHS model. Of the FHS model MHUs, one (0.9%) was created during the study period. In April 2015, SMS-Curitiba had 512 PHC physicians, 433 of which remained at the same MHU throughout the 12-month study period. Seventy-seven (17.8%) were classified as FP; 117 (27.0%) as BSP; 37 (8.5%) as SUBP, and 202 (46.7%) had no specialty recognized by the CNRM or AMB.

Figure 1 shows the selection of AIH for analysis according to inclusion and exclusion criteria. The mean values of each variable studied are shown in Table 1, accompanied by standard deviation.

The coverage areas of FHS model MHUs exhibited worse socioeconomic conditions compared to EAB units. Among FHS model MHUs, a negative association was observed between Equivalent FP and the variables Lit.Rt and Income. The same was true for the variables Total Equivalent and SUBP Equivalent, while the opposite was observed for the group BSP Equivalent.

Figure 1. Selection of AIH for analysis according to inclusion and exclusion criteria.

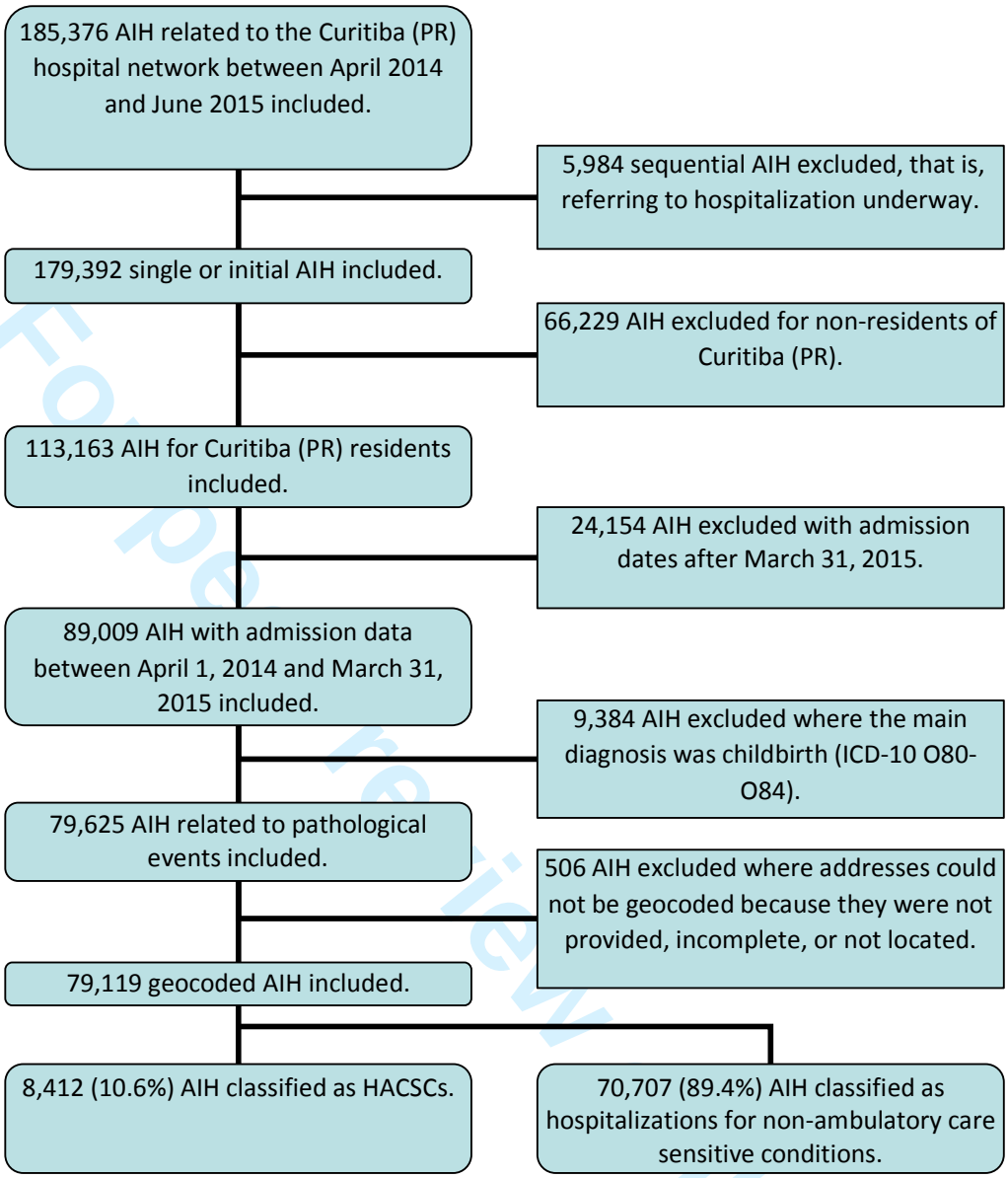

Table 1. Means and standard deviations for socioeconomic variables, hospitalization rates, and 40-hour week Physician equivalents according to MHU models. Curitiba, Brazil.

Study variables	EAB (n=44 MHUs)		FHS (n=65 MHUs)		Total (n=109 MHUs)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Socioeconomic variables						
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	98.4	0.7	96.8	1.4	97.4	1.4
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	16.8	5.4	27.6	8.2	23.2	8.9
Per capita income (R$) – Income	1,232.57	493.16	777.17	429.07	961.00	506.28
Percentage of households with a per capita income below minimum wage (%) – Perc.House	6.0	2.6	12.6	5.8	10.0	5.8
Hospitalization rates per year per 10,000 inhabitants						
Total	418.7	127.9	499.4	154.0	466.8	148.9
ACSC	46.0	13.7	47.7	14.2	47.0	14.0
Bacterial Pneumonia - BP	11.8	5.9	12.9	6.2	12.5	6.1
Angina	8.2	3.2	8.3	4.2	8.3	3.9
Heart Failure - HF	8.0	2.9	7.7	3.2	7.8	3.1
40-hour week Physician equivalents per 10,000 inhabitants.						
Average supply	2.10	0.76	3.51	1.50	2.94	1.43
Family Physician - FP	0.06	0.12	0.89	1.10	0.55	0.95
Basic specialists (Clinicians. Pediatrics and Gynecologists) - BSP	0.75	0.47	0.21	0.40	0.43	0.50
Subspecialty Physicians - SUBP	0.17	0.20	0.19	0.50	0.18	0.40
Physicians at the same MHU for 12 months - Total	1.77	0.73	2.58	1.28	2.25	1.16

The results of hierarchical linear regression coefficients in models 1 and 2 are presented in Tables 2 and 3, respectively. Values statistically significant at 5% are identified in the tables. For ACSCs, results statistically significant at 10% are also marked.

Socioeconomic variables were alternately significant for all the dependent variables when all the MHUs were analyzed, except for HACSC for angina, indicating that the better the socioeconomic conditions, the lower the hospitalization rates. In analysis of FHS model MHUs, only the association between the Lit.Rt and hospitalization rates for BP was statistically significant at 5%.

The FHS model was associated with fewer HACSCs (on average 6.0 fewer hospitalizations a year per 10,000 inhabitants in relation to the EAB model), statistically significant at 5%. A statistically significant association was also observed between the availability of FP and fewer HACSCs for HF in FHS model MHUs (1.1 fewer hospitalizations a year per 10,000 inhabitants for every 40-hour week FP per 10,000 inhabitants). The variable Total equivalent was significantly correlated with higher HACSC rates in all the MHUs, as well as higher total hospitalization rates and admissions due to ACSCs in FHS model MHUs. The variables Average Supply Equivalent, BSP Equivalent and SUBP Equivalent were not significantly associated with any of the outcomes studied.

Table 2. Results of hospitalization coefficients and p-values for model 1 of the socioeconomic variable for all MHUs and FHU model units. Curitiba, Brazil.

Socioeconomic variables	Total		ACSC		Heart Failure - HF		Angina		Bacterial Pneumonia - BP	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Total (n=109 MHUs)										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-55.0[a].**	**<0.001**	*	*	-0.1	0.861	-0.1	0.801	**-1.7[a]**	**<0.001**
Per capita income (R$ 100.00) – Income	*-5.2[b]*	*0.129*	**-1.2[a]**	**<0.001**	**-0.2[a]**	**0.007**	-0.1	0.347	-0.1	0.382
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	0.2	0.504	*	*	*	*	*	*
FHS model MHUs (n=64)										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-42.5[a]**	**0.001**	**-3.4[a]**	**0.006**	*-0.5[b]*	*0.059*	*	*	**-1.7[a]**	**0.002**
Per capita income (R$ 100.00) – Income	2.2	0.688	-0.4	0.440	-0.1	0.784	-0.1	0.804	0.1	0.535
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	-0.1	0.480	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*

[a] Value p<0.05. [b] Value p<0.20.

Table 3. Results of hospitalization coefficients and p-values for model 2 of the socioeconomic variables, 40-hour week Physician equivalents and PHC model for all MHUs and FHU model units. Curitiba, Brazil.

Variables	Total		ACSC		Heart Failure - HF		Angina		Bacterial Pneumonia - BP	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Total (n=109 MHUs)										
Socioeconomic variables										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-32.5**[a]	**0.015**	*	*	*	*	*	*	**-2.1**[a]	**0.000**
Per capita income (R$ 100.00) – Income	-4.9	0.151	**-1.2**[a]	**0.000**	**-0.2**[a]	**0.001**	*	*	*	*
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*
40-hour week Physician equivalents per 10,000 inhabitants.										
Average supply	-25.8	0.187	-2.0	0.260	-0.5	0.226	-0.6	0.224	-0.8	0.367
Basic specialists (Clinicians, Pediatrics and Gynecologists) - BSP	-7.5	0.811	-2.7	0.361	0.1	0.920	-0.7	0.427	-1.3	0.334
Subspecialty Physicians - SUBP	14.2	0.644	2,2	0.465	-0.1	0.908	-0.4	0.673	-0.5	0.697
Physicians at the same MHU for 12 months - Total	*22.1*[c]	*0.080*	**2.6**[a]	**0.023**	0.4	0.152	0.4	0.172	0.7	0.201
PHC Model										
PHC Model (EAB=0, FHS=1)	-13.1	0.665	**-6.0**[a]**.**	**0.030**	*-1.2*[c]	*0.062*	-0.3	0.761	*-2.3*[c]	*0.078*
FHS model MHUs (n=64)										
Socioeconomic variables										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	-23.8	0.104	*-2.3*[c]	*0.088*	-0.4	0.203	*	*	**-1.7**[a]	**0.002**
Per capita income (R$ 100.00) – Income	*	*	*	*	*	*	*	*	*	*
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*

Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*
40-hour week Physician equivalents per 10,000 inhabitants.										
Average supply	-9.6	0.720	-2.7	0.289	-0.2	0.736	-0.9	0.136	-0.8	0.402
Family Physician - FP	*-38.6* [c]	*0.057*	*-3.2* [c]	*0.091*	**-1.1** [a]	**0.016**	0.7	0.243	-0.1	0.959
Basic specialists (Clinicians, Pediatrics and Gynecologists) - BSP	*-87.0* [c]	*0.070*	-6.4	0.157	-0.5	0.613	-0.7	0.636	-2.6	0.170
Subspecialty Physicians - SUBP	-0.2	0.997	0.3	0.937	-0.7	0.379	0.3	0.787	-0.1	0.994
Physicians at the same MHU for 12 months - Total	**51.2**[a]**.**	**0.012**	**4.0** [a]	**0.026**	*0.8* [c]	*0.060*	0.5	0.251	1.0	0.107

[a] Value p<0.05. [c] Value p<0.10.

Some results were only statistically significant at 10%, as follows: 1) FHS model and lower HACSC rates for HF and BP; 2) FP Equivalent and lower total hospitalization and HACSC rates in FHS model MHUs; 3) BSP Equivalent and lower total hospitalization rate in FHS model MHUs; 4) Total Equivalent and higher total hospitalization rate in total MHUs and higher HACSC rates for HF under the FHS model; and 5) Lit.Rt and lower HACSC rates under the FHS model.

DISCUSSION:

In the present study, after adjustment for age and sex and control of socioeconomic variables, low HACSC rates were significantly associated with the FHS model and the presence of FP in the municipality of Curitiba (PR). No significant associations were observed between HACSC and other medical specialties, with worse results found for the total number of doctors present over the 12-month study.

The association between the FHS model and low HACSC rates is consistent with other studies.(12,13,15) Although Curitiba exhibited one of the lowest HACSC rates among Brazilian capitals, the difference between the models (FHS and EAB) was equivalent to 13% of the municipality's HACSC for the period. The FHS model was also correlated with fewer hospitalizations for HF and BP, both statistically significant at 10%. These results reinforce the knowledge accumulated in the literature, which justify maintaining, expanding and consolidating this strategy in the country, even in socially and economically developed municipalities such as Curitiba.

Among the FHS model units, the presence of FP was significantly associated with lower hospitalization rates for HF, the main cause of HACSC in the elderly population of Curitiba during the study period. The presence of one 40-hour work week FP per 10,000 inhabitants was related to 14% fewer hospitalizations for this condition in the municipality. This suggests that the presence of these professionals could have a potentially significant impact on the country, since HF is also the main cause of HACSC in Brazil.(19)

FP were also significantly associated with the total hospitalization and overall HACSC rates. Although results were significant at 10% but not 5%, the association was clinically significant. For every 40-hour work week physician per 10,000 inhabitants, there were 3.2 fewer ACSC-related hospitalizations a year per 10,000 inhabitants. Considering the recommendation of the 2012 National Primary Care Policy that each FHS team should cover an average of 3,000 people, based on the results found, one would expect a reduction of 9.6 hospitalizations for ACSCs a year per 10,000 inhabitants, if 3 FP are present in comparison to 3 physicians without this specialty.(9) This could represent a more than 20% drop in the average for the municipality, regardless of other factors.

Despite being associated with the PHC model at 10% significance, hospitalization for BP, the main cause of HACSC among children (0-14 years), did not appear to be related to the presence of FP in this study. This can be explained by the fact that BP is an acute condition, unlike HF. Considering the essential attributes of PHC, the literature indicates a strong overall relationship between access and HACSC.(20-22) In terms of longitudinal care/continuity, studies have found an inverse association with only chronic ACSCs.(23,24) Thus, it can be concluded that the access provided by MHUs is more relevant when treating BP, which is less influenced by FM specialty. On the other hand, in cases of HF, both access and qualified longitudinal care are essential to achieve fewer hospitalizations.

Hospitalizations for angina, the main cause of HACSCs in the 15 to 64-year age group, were not associated with any variables, whether socioeconomic or health service-related. The short study period of 12 months may explain this finding. Moreover, this condition typically develops over decades and is heavily influenced by risk factors related to the individual's lifestyle. Although angina is considered an ACSC, the extent to which health care services can modify its progression is debatable.

Basic specialists at the same MHU for the 12-month study period were associated to lower total hospitalization rate in FHS model MHUs at 10% significance, but not to lower HACSC rates, which suggests it is a spurious association. Subspecialists at the same MHU for

the 12-month study period were not significantly related to any of the dependent variables. This finding suggests that FM is superior to other specialties in PHC settings in terms of reducing HACSCs. Contrary to the findings of other studies, the average supply of doctors in the study period was not associated with any of the dependent variables assessed.(20,22) This may be due to the adequate supply of physicians in terms of the municipality's needs. Unexpectedly, the total number of doctors at the same MHU throughout the 12-month study, almost half of whom were not registered as specialists on official databases, was significantly related to worse hospitalization rates for some conditions. Although certain limitations of this study may explain some of these findings, the results strongly suggest that medical specialties in PHC may play an important role in care quality and the impact of outcomes on health, whether positive or negative.

Limitations:

With respect to the limitations, the first is inherent to the study design; as such, it cannot be concluded that the findings presented here on an ecological level necessarily reflect associations on an individual level. However, the hypothesis that both the PHC model and the medical specialty best suited to primary care can reduce hospitalizations for ACSCs, one of the main indicators used to assess the quality of PHC, seems plausible.

The study period was too short to properly analyze the outcomes. A study of elderly individuals in the United States suggested a minimum doctor-patient relationship of 5 to 10 years was needed to obtain a significant variation in the hospitalization rates of these patients.(25) However, the high turnover rate of PHC physicians in Brazil combined with the difficulty in collecting older data on municipal health services made it impossible to lengthen the study period.

Working in this study with a small number of the MHUs (109 MHUs in total and 65 FHS model MHUs) compromised the statistical power and can justify the scarcity of statistically significant results at the 5% significance. Due to this, we also worked with a 10% significance level for initially non-significant associations at 5%, in order not to neglect clinically meaningful results.

Some confounding factors potentially relevant to the outcome studied were not explored in this study. Among these factors, we can mention for example characteristics of the multiprofessional team, involvement with teaching activities, beginning of professionals and

teams work in the area, presence of other social equipment in the territory and the existence of geographic or socio-organizational barriers to access.

Finally, there are two other noteworthy limitations. The study used population data from the 2010 Census, whereas hospitalization data were from April 2014 to March 2015. In addition, hospitalization data were obtained from AIH, a hospital reimbursement tool used exclusively in the public health system with no information on private admissions (funded by health care plans, health insurance or individuals). However, Curitiba has shown little population change, with growth estimated at only 7% between 2010 and 2015. This growth is not homogeneous across the municipality and areas with unfavorable socioeconomic conditions show the greatest expansion.(26,27) As such, hospitalization rates for the most vulnerable regions of Curitiba may have been overestimated in relation to other areas in this study, owing to overestimation of its population in 2015, whose growth potential would have been greater between 2010 and 2015, and non-notification of private hospital admissions in wealthier areas. This did not prevent findings of better outcomes associated with the FHS model and the family medicine specialty, but may explain the absence and/or fragility of other associations observed as well as the worse outcomes related to the total number of doctors at the same MHU for 12 months.

CONCLUSION:

Based on hospitalization rates adjusted for age and sex and controlled analysis of socioeconomic factors whose influence on hospitalization is recognized in the literature, the FHS model was significantly associated with lower HACSC rates and the availability of FP was significantly correlated with lower HACSC rates due to HF in Curitiba (PR) from April 2014 to March 2015.

The fact that the best outcomes recorded in a major Brazilian municipality known for its well organized health system were associated with the FHS model reinforces FHS as the preferred organization model for PHC in Brazil. On the other hand, the statistically significant association between the presence of FP and lower HF rates, the leading cause of HACSCs among the elderly in Curitiba, may be an effective means of reducing financial costs and human suffering, since the aging of the Brazilian population suggest a current and future increase in chronic disease.

It is important to underscore that basic specialties, as well as those in other medical fields (called subspecialties) were not significantly associated with any HACSCs rates studied.

Finally, the association between the total number of doctors at the same MHU for the 12-month study period, almost half of whom were not specialists, and higher hospitalization rates calls for urgent reflection on the possibility of iatrogenesis in PHC and the need to implement mandatory medical specialties after the completion of undergraduate medical courses, as occurs in several first world countries. The findings of this study should be confirmed by further in-depth assessments that eliminate or minimize the limitations presented.

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FOOTNOTES

- **Contributors** MPDA conceived the study. MPDA, HES, EMH and WMR designed the study. MPDA collected and organized data. MPDA, HES, EMH, WMR and TA analyzed data. MPDA drafted the manuscript. All the authors revised the article and agreed with the final version and findings.
- **Funding** None.
- **Competing interests** MPDA served as vice president for the Family Medicine Association of Brasilia (ABrMFC) Board of Directors from 2014 to 2015. ABrMFC is a non-profit professional and scientific regional association, affiliated with the Brazilian Family Medicine Society (SBMFC).
- **Ethics approval** This study was approved by the Research Ethics Committees of the Coordinating (FS/UnB, CAAE 42275414.0.0000.0030) and Partner Institutions (SMS-Curitiba, CAAE 42275414.0.3001.0101).
- **Provenance and peer review** Not commissioned.

- **Data sharing statement** The hospitalization rates, socioeconomic indicators and medical workload per MHU have not been published and are available by emailing MPDA.

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Title: Can specializing in Family Medicine reduce Hospitalization for Ambulatory Care Sensitive Conditions? Evidence from a cross-sectional ecological study.

Authors: AFONSO, MPD; SHIMIZU, HE; MERCHAN-HAMANN, E; RAMALHO, WM; AFONSO, T

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**YES**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**YES**
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	**YES**
Objectives	3	State specific objectives, including any prespecified hypotheses	**YES**
Methods			
Study design	4	Present key elements of study design early in the paper	**YES**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**YES**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**YES**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**YES**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**YES**
Bias	9	Describe any efforts to address potential sources of bias	**YES**
Study size	10	Explain how the study size was arrived at	**YES**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**YES**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**YES**
		(*b*) Describe any methods used to examine subgroups and interactions	**N.A.**
		(*c*) Explain how missing data were addressed	**N.A.**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**N.A.**
		(*e*) Describe any sensitivity analyses	**NO**
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**YES**
		(b) Give reasons for non-participation at each stage	**YES**
		(c) Consider use of a flow diagram	**YES**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**YES**

		(b) Indicate number of participants with missing data for each variable of interest	N.A.
Outcome data	15*	Report numbers of outcome events or summary measures	YES
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	YES
		(*b*) Report category boundaries when continuous variables were categorized	YES
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	YES
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NO
Discussion			
Key results	18	Summarise key results with reference to study objectives	YES
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	YES
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	YES
Generalisability	21	Discuss the generalisability (external validity) of the study results	YES
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	YES

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Association between Hospitalization for Ambulatory Care Sensitive Conditions and Primary Health Care physician specialization: a cross-sectional ecological study in Curitiba (Brazil)

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Association between Hospitalization for Ambulatory Care Sensitive Conditions and Primary Health Care physician specialization: a cross-sectional ecological study in Curitiba (Brazil)

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Descriptors: PRIMARY HEALTH CARE, GENERAL PRACTICE, PUBLIC HEALTH, EPIDEMIOLOGY.

ABSTRACT: **Introduction:** Hospitalization for ambulatory care sensitive conditions (HACSCs) is frequently used as an indicator of the quality and effectiveness of primary health care (PHC) services around the world. The aim of the present study was to evaluate whether the PHC model (Family Health Strategy-FHS- x conventional) and the availability of specialized PHC physicians is associated or not with total hospitalization or HACSCs in the National Health System (SUS) of the municipality of Curitiba, Paraná state (PR), Brazil. **Methodology:** this is a cross-sectional ecological study using multiple linear regression with socioeconomic and professional data from Municipal Health Units (MHUs) between April 1, 2014 and March 31, 2015. **Results:** after adjustment for age and sex and control of socioeconomic variables, the FHS model was associated with six fewer HACSCs a year per 10,000 inhabitants in relation to the conventional model and the availability of one Family Physician (FP) at each FHS model MHU per 10,000 inhabitants was associated with 1.1 fewer HACSCs for heart failure (HF) a year per 10,000 inhabitants; both results were statistically significant at 5%. Basic Specialists (Clinicians, Pediatricians and Obstetrician/Gynecologists) and Subspecialists showed no significant association with HACSC rates. **Conclusion:** these results obtained in a major Brazilian city reinforce the role of FHS as a priority PHC model in the country and indicate the potentially significant impact of specializing in Family Medicine on improving the health conditions of the population.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- This study was carried out in an important Brazilian city with high primary health care service coverage where resources are uniformly distributed among health units regardless of their PHC model, allowing reliable analysis of the association between PHC model, medical specialization and hospitalizations for ambulatory care sensitive conditions.
- The socioeconomic and hospitalization data used were obtained from reliable official sources.

- Hospitalizations were adjusted for age, sex and socioeconomic variables, important confounders for the outcomes of interest.
- The short duration of PHC physicians' presence in the MHUs assessed (12 months) and the small number of MHUs studied reduced the power of the study.
- The cross-sectional ecological design is unable to establish a causality relationship between the variables studied.

INTRODUCTION:

Primary health care (PHC) is the first-contact level and the backbone of rational National Health Systems, responsible for providing accessible, continuous, comprehensive and coordinated health care to the population.(1) An important indicator of the quality and effectiveness of this care is the rate of hospitalizations for ambulatory care sensitive conditions (HACSCs).(2-5) These are conditions of needed hospitalization that can be avoided through the provision of timely and qualified PHC services by 1) preventing the onset of disease, 2) adequately controlling acute illness or 3) effectively managing chronic conditions.(6) Brazil has had a National List of Ambulatory Care Sensitive Conditions since 2008.(7,8)

In Brazil, the preferred PHC organization model within the National Health System (SUS) is the Family Health Strategy (FHS).(9) FHS teams consist of a general practitioner, a professional nurse, one or two assistant nurses and 4 to 12 community health agents, caring for 3000 people on average.(9) Nevertheless, the so-called conventional model, based on ambulatory care in the Basic Specialties of Pediatrics, Internal Medicine and Gynecology and Obstetrics persists, particularly in large cities.(10,11) PHC physicians are not legally required to have a specialty. Physicians become specialists in Family Medicine in Brazil after completing two-year Medical Residency program or through a certification examination after 4 years' experience in the field.

Several studies have demonstrated an association between FHS coverage and a decline in HACSCs.(12-15) Between 1999 and 2007, chronic HACSC rates in municipalities with greater FHS coverage were 13% lower in relation to those with less coverage, reaching 23% for hospitalization due to asthma.(16)

A recent study found a significant association between specializing in Family Medicine and the strength of PHC attributes in the FHS of an important Brazilian capital, measured using the PCA-tool.(17) Thus, it can be speculated that specific medical training for PHC in Brazil is

related to both major and intermediate health outcomes. If lower HACSC rates are expected with access to qualified clinical care, medical specialties aimed at training PHC professionals should, in theory, influence this outcome. However, studies that assess the relationship between the specialties of PHC physicians and health outcomes remain scarce.

The aim of the present study was to evaluate whether the PHC model and the availability of specialized PHC physicians are associated or not with total hospitalization or HACSC rates in the National Health System (SUS) of the municipality of Curitiba, Paraná state (PR).

METHODOLOGY:

This is a cross-sectional ecological study conducted in the municipality of Curitiba (PR), Brazil. The municipality exhibits high PHC coverage, particularly in terms of FHS, which reached 52% of the population in April 2014.(18) Moreover, a high number of Family Physicians is reported in comparison to other Brazilian capitals, and health care services have been computerized for over a decade.(10) The units of analysis were Municipal Health Units (MHUs), classified as a Family Health Strategy (FHS) or Conventional (EAB) in accordance with the PHC model of their teams.

Data:

Socioeconomic data by census tract were obtained from 2010 Census databases, provided by the Brazilian Institute of Geography and Statistics (IBGE).

Information on hospital admissions was obtained from the Hospital Information System (SIH), through registered Hospitalization Authorization Forms (AIH). Inclusion criteria were single or initial AIH, valid until June 2015, for Curitiba (PR) residents hospitalized in the municipality between April 1, 2014 and March 31, 2015. Hospital admissions for childbirth (International Classification of Diseases, 10th edition - ICD-10 - O.80 to O.84) were excluded as physiological events.(7)

AIH information and socioeconomic data were aggregated at the level of the MHU coverage areas, using QuantumGIS software, version 2.10 Pisa. Addresses on AIH were geocoded using the MMQGIS plugin and GoogleMaps server.

Quantitative data and information on the specialties of PHC physicians in Curitiba (PR) during the study period were obtained from databases of the Curitiba Municipal Health

Department (SMS-Curitiba), Regional Board of Medicine for the State of Paraná, Brazilian Medical Association (AMB), and the National Medical Residency Committee (CNRM).

The MHU model and doctors' working hours were used as predictor variables. Doctors were classified as 1) Family Physicians (FP); 2) Basic Specialty Physicians (BSP); or 3) Subspecialty Physicians (SUBP) if they had concluded their medical residency through the CNRM or been awarded a degree by a scientific association recognized by the AMB prior to May 31, 2015, in the fields of 1) Family Medicine (FM); 2) Internal Medicine, Pediatrics or Gynecology and Obstetrics; and 3) other Medical Specialties, respectively.

The average supply of doctors was calculated using the mean total working hours of physicians in each MHU during the study period. For physicians who remained at the same MHU for the 12-month study period, total effective working hours were added to working hours per category for each MHU, according to the classification above. For each amount, the ratio of working hours to the total population residing in the MHU coverage area (2010 Census) was calculated. In order to facilitate understanding, variables were presented as "Full Time Equivalents", which represent the number of physicians with a 40-hour work week.

As outcome variables for each MHU, total hospitalization rates were calculated, as well as HACSCs and the main ambulatory care sensitive condition per age group, namely bacterial pneumonia (BP) in childhood (0-14 years), angina in adulthood (15-64 years) and heart failure (HF) in the elderly (65 years and older). Hospitalization rates were standardized for age and sex via the direct method, using the structure of the population of Curitiba (PR) according to the 2010 Census as reference. In order to calculate hospitalization rates, the population in the respective MHU coverage areas was used as a denominator, in accordance with the 2010 Census. -HACSCs were defined as those for which the "Main Diagnosis" field of the AIH contained a disease classified by an ICD-10 code as belonging to the Brazilian List of Ambulatory Care Sensitive Conditions.(8) Due to its high incidence rate, records for which the main diagnosis was ICD-10 J18.9 (Pneumonia; unspecified organism) were included in this study as BP.

Four socioeconomic variables relevant to the studied outcomes were adopted as context per MHU: 1) literacy rate in the population aged 10 years or older (Lit.Rt); 2) percentage of blacks, mulattos and native Brazilians (Pop.Perc); 3) Per capita income (Income); and 4) percentage of households with a per capita income below half the minimum wage (Perc.House).

Data analysis:

SPSS Statistics software version 18 (PASW Statistics 18) was used for data analysis. Calculation of the variance inflation factor (VIF) identified high collinearity (VIF>5) between the socioeconomic variables Lit.Rt, Pop.Perc and Perc.House, preventing their concomitant use in the analysis, but not between variables related to physician working hours. Working hours per medical category were similar between EAB and FHS model MHUs, except for FP, whose working hours were 15 times higher at FHS model MHUs than conventional (EAB) units.

In order to estimate the effects of predictor variables independently of socioeconomic variables, hierarchical linear regression with stepwise-backward elimination was carried out for each dependent variable studied, with an F-to-enter statistic of 0.10 and F-to-remove of 0.20, initially for all the MHUs and subsequently for FHS model MHUs. The variable related to the FP category was only used in the latter given its significant association with this model.

Two models were constructed. Model 1 included the variable "Income" and, among the socioeconomic variables exhibiting high collinearity, the variable with the greatest Beta value in simple regression for the dependent variable under study. Variables with a p-value lower than 0.20 were maintained and fixed for model 2, which included the other variables under study. The results were presented as non-standardized coefficients and considered significant at 5%. Results significant at 10% were identified for HACSCs.

RESULTS:

The study included 109 MHUs, 44 (40.4%) of which were conventional (EAB) and 65 (59.6%) applied the FHS model. Of the FHS model MHUs, one (0.9%) was created during the study period. In April 2015, SMS-Curitiba had 512 PHC physicians, 433 of which remained at the same MHU throughout the 12-month study period. Seventy-seven (17.8%) were classified as FP; 117 (27.0%) as BSP; 37 (8.5%) as SUBP, and 202 (46.7%) had no specialty recognized by the CNRM or AMB.

Figure 1 shows the selection of AIH for analysis according to inclusion and exclusion criteria. The mean values of each variable studied are shown in Table 1, accompanied by standard deviation.

Figure 1. Selection of AIH for analysis according to inclusion and exclusion criteria.

Table 1. Means and standard deviations for socioeconomic variables, hospitalization rates, and full time equivalents according to MHU models. Curitiba (PR), Brazil.

Study variables	EAB (n=44 MHUs)		FHS (n=65 MHUs)		Total (n=109 MHUs)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Socioeconomic variables						
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	98.4	0.7	96.8	1.4	97.4	1.4
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	16.8	5.4	27.6	8.2	23.2	8.9
Per capita income (R$) – Income	1,232.57	493.16	777.17	429.07	961.00	506.28
Percentage of households with a per capita income below minimum wage (%) – Perc.House	6.0	2.6	12.6	5.8	10.0	5.8
Hospitalization rates per year per 10,000 inhabitants						
Total	418.7	127.9	499.4	154.0	466.8	148.9
HACSCs	46.0	13.7	47.7	14.2	47.0	14.0
Bacterial Pneumonia - BP	11.8	5.9	12.9	6.2	12.5	6.1
Angina	8.2	3.2	8.3	4.2	8.3	3.9
Heart Failure - HF	8.0	2.9	7.7	3.2	7.8	3.1
Full time equivalents per 10,000 inhabitants.						
Average supply	2.10	0.76	3.51	1.50	2.94	1.43
Family Physician - FP	0.06	0.12	0.89	1.10	0.55	0.95
Basic Specialists (Clinicians, Pediatrics and Gynecologists) - BSP	0.75	0.47	0.21	0.40	0.43	0.50
Subspecialty Physicians - SUBP	0.17	0.20	0.19	0.50	0.18	0.40
Physicians at the same MHU for 12 months - Total	1.77	0.73	2.58	1.28	2.25	1.16

The coverage areas of FHS model MHUs exhibited worse socioeconomic conditions compared to EAB units. Among FHS model MHUs, a negative association was observed between Equivalent FP and the variables Lit.Rt and Income. The same was true for the variables Total Equivalent and SUBP Equivalent, while the opposite was observed for the group BSP Equivalent.

The results of hierarchical linear regression coefficients in models 1 and 2 are presented in Tables 2 and 3, respectively. Values statistically significant at 5% are identified in the tables. For HACSCs, results statistically significant at 10% are also marked.

Socioeconomic variables were alternately significant for all the dependent variables when all the MHUs were analyzed, except for angina-related HACSCs, indicating that the better the socioeconomic conditions, the lower the hospitalization rates. In analysis of FHS model MHUs, only the association between the Lit.Rt and hospitalization rates for BP was statistically significant at 5%.

The FHS model was associated with fewer HACSCs (on average 6.0 fewer hospitalizations a year per 10,000 inhabitants in relation to the EAB model), statistically significant at 5%. A statistically significant association was also observed between the availability of FP and fewer HACSCs for HF in FHS model MHUs (1.1 fewer hospitalizations a year per 10,000 inhabitants for every 40-hour week FP per 10,000 inhabitants). The variable Total equivalent was significantly correlated with higher HACSC rates in all the MHUs, as well as higher total hospitalization rates and admissions due to ambulatory care sensitive conditions in FHS model MHUs. The variables Average Supply Equivalent, BSP Equivalent and SUBP Equivalent were not significantly associated with any of the outcomes studied.

Table 2. Results of hospitalization coefficients and p-values for model 1 of the socioeconomic variable for all MHUs and FHS model MHUs. Curitiba (PR), Brazil.

Socioeconomic variables	Total		HACSCs		Heart Failure - HF		Angina		Bacterial Pneumonia - BP	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Total (n=109 MHUs)										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-55.0[a].**	**<0.001**	*	*	-0.1	0.861	-0.1	0.801	**-1.7[a]**	**<0.001**
Per capita income (R$ 100.00) – Income	*-5.2[b]*	*0.129*	**-1.2[a]**	**<0.001**	**-0.2[a]**	**0.007**	-0.1	0.347	-0.1	0.382
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	0.2	0.504	*	*	*	*	*	*
FHS model MHUs (n=64)										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-42.5[a]**	**0.001**	**-3.4[a]**	**0.006**	*-0.5[b]*	*0.059*	*	*	**-1.7[a]**	**0.002**
Per capita income (R$ 100.00) – Income	2.2	0.688	-0.4	0.440	-0.1	0.784	-0.1	0.804	0.1	0.535
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	-0.1	0.480	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*

[a] Value p<0.05. [b] Value p<0.20.

Table 3. Results of hospitalization coefficients and p-values for model 2 of the socioeconomic variables, full time equivalents and PHC model for all MHUs and FHS model MHUs. Curitiba (PR), Brazil.

Variables	Total		HACSCs		Heart Failure - HF		Angina		Bacterial Pneumonia - BP	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Total (n=109 MHUs)										
Socioeconomic variables										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-32.5**[a]	**0.015**	*	*	*	*	*	*	**-2.1**[a]	**0.000**
Per capita income (R$ 100.00) – Income	-4.9	0.151	**-1.2**[a]	**0.000**	**-0.2**[a]	**0.001**	*	*	*	*
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*
Full time equivalents per 10,000 inhabitants.										
Average supply	-25.8	0.187	-2.0	0.260	-0.5	0.226	-0.6	0.224	-0.8	0.367
Basic Specialists (Clinicians, Pediatrics and Gynecologists) - BSP	-7.5	0.811	-2.7	0.361	0.1	0.920	-0.7	0.427	-1.3	0.334
Subspecialty Physicians - SUBP	14.2	0.644	2,2	0.465	-0.1	0.908	-0.4	0.673	-0.5	0.697
Physicians at the same MHU for 12 months - Total	*22.1*[c]	*0.080*	**2.6**[a]	**0.023**	0.4	0.152	0.4	0.172	0.7	0.201
PHC Model										
PHC Model (EAB=0, FHS=1)	-13.1	0.665	**-6.0**[a]**.**	**0.030**	*-1.2*[c]	*0.062*	-0.3	0.761	*-2.3*[c]	*0.078*
FHS model MHUs (n=64)										
Socioeconomic variables										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	-23.8	0.104	*-2.3*[c]	*0.088*	-0.4	0.203	*	*	**-1.7**[a]	**0.002**
Per capita income (R$ 100.00) – Income	*	*	*	*	*	*	*	*	*	*
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*

Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*
Full time equivalents per 10,000 inhabitants.										
Average supply	-9.6	0.720	-2.7	0.289	-0.2	0.736	-0.9	0.136	-0.8	0.402
Family Physician - FP	*-38.6* [c]	*0.057*	*-3.2* [c]	*0.091*	**-1.1** [a]	**0.016**	0.7	0.243	-0.1	0.959
Basic Specialists (Clinicians, Pediatrics and Gynecologists) - BSP	*-87.0* [c]	*0.070*	-6.4	0.157	-0.5	0.613	-0.7	0.636	-2.6	0.170
Subspecialty Physicians - SUBP	-0.2	0.997	0.3	0.937	-0.7	0.379	0.3	0.787	-0.1	0.994
Physicians at the same MHU for 12 months - Total	**51.2**[a]**.**	**0.012**	**4.0** [a]	**0.026**	*0.8* [c]	*0.060*	0.5	0.251	1.0	0.107

[a] Value p<0.05. [c] Value p<0.10.

Some results were only statistically significant at 10%, as follows: 1) FHS model and lower HACSC rates for HF and BP; 2) FP Equivalent and lower total hospitalization and HACSC rates in FHS model MHUs; 3) BSP Equivalent and lower total hospitalization rate in FHS model MHUs; 4) Total Equivalent and higher total hospitalization rate in total MHUs and higher HACSC rates for HF under the FHS model; and 5) Lit.Rt and lower HACSC rates under the FHS model.

DISCUSSION:

In the present study, after adjustment for age and sex and control of socioeconomic variables, lower HACSC rates were significantly associated with the FHS model and the presence of FP in the municipality of Curitiba (PR), Brazil. No significant associations were observed between HACSCs and other medical specialties, while worse results were found for the total number of doctors present over the 12-month study.

The association between the FHS model and low HACSC rates is consistent with other studies.(12,13,15) Although Curitiba exhibited one of the lowest HACSC rates among Brazilian capitals, the difference between the models (FHS and EAB) was equivalent to 13% of the municipality's HACSCs for the period. The FHS model was also correlated with fewer hospitalizations for HF and BP, both statistically significant at 10%. These results reinforce the knowledge accumulated in the literature, which justify maintaining, expanding and consolidating this strategy in the country, even in socially and economically developed municipalities such as Curitiba.

Among the FHS model units, the presence of FP was significantly associated with lower hospitalization rates for HF, the main cause of HACSCs in the elderly population of Curitiba during the study period. The presence of one 40-hour work week FP per 10,000 inhabitants was related to 14% fewer hospitalizations for this condition in the municipality. This suggests that the presence of these professionals could have a potentially significant impact on the country, since HF is also the main cause of HACSCs in Brazil.(19)

FP were also significantly associated with the total hospitalization and overall HACSC rates. Although results were significant at 10% but not 5%, the association was clinically significant. For every 40-hour work week physician per 10,000 inhabitants, there were 3.2 fewer HACSCs a year per 10,000 inhabitants. Considering the recommendation of the 2012 National Primary Care Policy that each FHS team should cover an average of 3,000 people, based on the results found, one would expect a reduction of 9.6 HACSCs a year per 10,000 inhabitants, if 3 FP are present in comparison to 3 physicians without this specialty.(9) This could represent a more than 20% drop in the average for the municipality, regardless of other factors.

Despite being associated with the PHC model at 10% significance, hospitalization for BP, the main cause of HACSCs among children (0-14 years), did not appear to be related to the presence of FP in this study. This can be explained by the fact that BP is an acute condition, unlike HF. Considering the essential attributes of PHC, the literature indicates a strong overall relationship between access and HACSCs.(20-22) In terms of longitudinal care/continuity, studies have found an inverse association with only chronic ambulatory care sensitive conditions.(23,24) Thus, it can be concluded that the access provided by MHUs is more relevant when treating BP, which is less influenced by FM specialty. On the other hand, in cases of HF, both access and qualified longitudinal care are essential to achieve fewer hospitalizations.

Hospitalizations for angina, the main cause of HACSC in the 15 to 64-year age group, were not associated with any variables, whether socioeconomic or health service-related. The short study period of 12 months may explain this finding. Moreover, this condition typically develops over decades and is heavily influenced by risk factors related to the individual's lifestyle. Although angina is considered an ambulatory care sensitive condition, the extent to which health care services can modify its progression is debatable.

Basic Specialists at the same MHU for the 12-month study period were associated to lower total hospitalization rate in FHS model MHUs at 10% significance, but not to lower

HACSC rates, which suggests it is a spurious association. Subspecialists at the same MHU for the 12-month study period were not significantly related to any of the dependent variables. This finding suggests that FM is superior to other specialties in PHC settings in terms of reducing HACSCs. Contrary to the findings of other studies, the average supply of doctors in the study period was not associated with any of the dependent variables assessed.(20,22) This may be due to the adequate supply of physicians in terms of the municipality's needs. Unexpectedly, the total number of doctors at the same MHU throughout the 12-month study, almost half of whom were not registered as specialists on official databases, was significantly related to worse hospitalization rates for some conditions. Although certain limitations of this study may explain some of these findings, the results strongly suggest that medical specialties in PHC may play an important role in care quality and the impact of outcomes on health, whether positive or negative.

Limitations:

With respect to the limitations, the first is inherent to the study design; as such, it cannot be concluded that the findings presented here on an ecological level necessarily reflect associations on an individual level. However, the hypothesis that both the PHC model and the medical specialty best suited to primary care can reduce HACSCs, one of the main indicators used to assess the quality of PHC, seems plausible.

The study period was too short to properly analyze the outcomes. A study of elderly individuals in the United States suggested a minimum doctor-patient relationship of 5 to 10 years was needed to obtain a significant variation in the hospitalization rates of these patients.(25) However, the high turnover rate of PHC physicians in Brazil combined with the difficulty in collecting older data on municipal health services made it impossible to lengthen the study period.

The small number of MHUs studied (109 MHUs in total and 65 FHS model MHUs) compromised the statistical power and may explain the scarcity of statistically significant results at 5% significance. As such, we also applied a 10% significance level for associations initially non-significant at 5% so as not to neglect clinically meaningful results

Some confounding factors potentially relevant to the outcomes studied were not explored here. These include characteristics of the multidisciplinary team, involvement with teaching activities, when professionals and teams began working in the area, presence of other

social resources in the area and the existence of geographic or socio-organizational barriers to access.

Finally, there are two other noteworthy limitations. The study used population data from the 2010 Census, whereas hospitalization data were from April 2014 to March 2015. In addition, hospitalization data were obtained from AIH, a hospital reimbursement tool used exclusively in the public health system with no information on private admissions (funded by health care plans, health insurance or individuals). However, Curitiba has shown little population change, with growth estimated at only 7% between 2010 and 2015. This growth is not homogeneous across the municipality and areas with unfavorable socioeconomic conditions show the greatest expansion.(26,27) As such, hospitalization rates for the most vulnerable regions of Curitiba may have been overestimated in relation to other areas in this study, owing to underestimation of its population in 2015, whose growth potential would have been greater between 2010 and 2015, and non-notification of private hospital admissions in wealthier areas. This did not prevent findings of better outcomes associated with the FHS model and the Family Medicine specialty, but may explain the absence and/or fragility of other associations observed as well as the worse outcomes related to the total number of doctors at the same MHU for 12 months.

CONCLUSION:

Based on hospitalization rates adjusted for age and sex and controlled analysis of socioeconomic factors whose influence on hospitalization is recognized in the literature, the FHS model was significantly associated with lower HACSC rates and the availability of FP was significantly correlated with lower HACSC rates due to HF in Curitiba (PR), Brazil, from April 2014 to March 2015.

The fact that the best outcomes recorded in a major Brazilian municipality known for its well organized health system were associated with the FHS model reinforces FHS as the preferred organization model for PHC in Brazil. On the other hand, the statistically significant association between the presence of FP and lower HF rates, the leading cause of HACSCs among the elderly in Curitiba, may be an effective means of reducing financial costs and human suffering, since the aging of the Brazilian population suggest a current and future increase in chronic disease.

It is important to underscore that Basic Specialties, as well as those in other medical fields (called Subspecialties) were not significantly associated with any HACSC rates studied.

Finally, the association between the total number of doctors at the same MHU for the 12-month study period, almost half of whom were not specialists, and higher hospitalization rates calls for urgent reflection on the possibility of iatrogenesis in PHC and the need to implement mandatory medical specialties after the completion of undergraduate medical courses, as occurs in several first world countries. The findings of this study should be confirmed by further in-depth assessments that eliminate or minimize the limitations presented.

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FOOTNOTES

- **Contributors** MPDA conceived the study. MPDA, HES, EMH and WMR designed the study. MPDA collected and organized data. MPDA, HES, EMH, WMR and TA analyzed data. MPDA drafted the manuscript. All the authors revised the article and agreed with the final version and findings.
- **Funding** None.
- **Competing interests** MPDA served as vice president for the Family Medicine Association of Brasilia (ABrMFC) Board of Directors from 2014 to 2015. ABrMFC is a non-profit professional and scientific regional association, affiliated with the Brazilian Family Medicine Society (SBMFC).
- **Ethics approval** This study was approved by the Research Ethics Committees of the Coordinating (FS/UnB, CAAE 42275414.0.0000.0030) and Partner Institutions (SMS-Curitiba, CAAE 42275414.0.3001.0101).
- **Provenance and peer review** Not commissioned.

- **Data sharing statement** The hospitalization rates, socioeconomic indicators and medical workload per MHU have not been published and are available by emailing MPDA.

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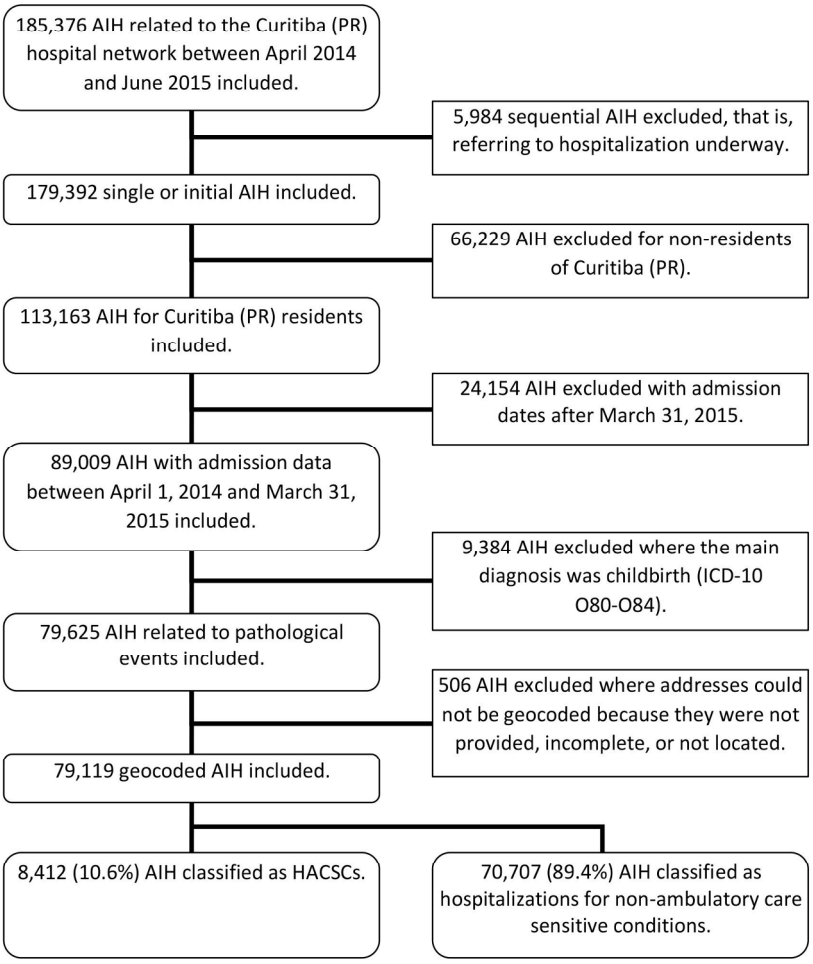

Figure 1. Selection of AIH for analysis according to inclusion and exclusion criteria.

177x202mm (300 x 300 DPI)

Title: Association between Hospitalization for Ambulatory Care Sensitive Conditions and Primary Health Care physician specialization: a cross-sectional ecological study in Curitiba (Brazil)

Authors: AFONSO, MPD; SHIMIZU, HE; MERCHAN-HAMANN, E; RAMALHO, WM; AFONSO, T

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Included (page)
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**YES (p. 1)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**YES (p. 1)**
Introduction			
Background / rationale	2	Explain the scientific background and rationale for the investigation being reported	**YES (p. 2-3)**
Objectives	3	State specific objectives, including any prespecified hypotheses	**YES (p. 3)**
Methods			
Study design	4	Present key elements of study design early in the paper	**YES (p. 3)**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**YES (p.3-4)**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**YES (p. 3-4)**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**YES (p.4)**
Data sources / measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**YES (p. 3-4)**
Bias	9	Describe any efforts to address potential sources of bias	**YES (p. 3)**
Study size	10	Explain how the study size was arrived at	**YES (p. 3-4)**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**YES (p. 4)**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**YES (p. 5)**
		(*b*) Describe any methods used to examine subgroups and interactions	**YES (p. 5)**
		(*c*) Explain how missing data were addressed	**YES (p. 6)**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**N.A.**
		(*e*) Describe any sensitivity analyses	**N.A.**
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**YES (p. 5-6)**
		(b) Give reasons for non-participation at each stage	**YES (p. 6)**
		(c) Consider use of a flow diagram	**YES (p. 6)**

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**YES (p. 7)**
		(b) Indicate number of participants with missing data for each variable of interest	**N.A.**
Outcome data	15*	Report numbers of outcome events or summary measures	**YES (p. 7)**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	**YES (p. 9-11)**
		(*b*) Report category boundaries when continuous variables were categorized	**N.A.**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	**YES (p. 8)**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	**N.A.**
Discussion			
Key results	18	Summarise key results with reference to study objectives	**YES (p. 11)**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	**YES (p. 13-14)**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	**YES (p.11-15)**
Generalisability	21	Discuss the generalisability (external validity) of the study results	**YES (p. 14)**
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	**YES (p. 15)**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Association between Hospitalization for Ambulatory Care Sensitive Conditions and Primary Health Care physician specialization: a cross-sectional ecological study in Curitiba (Brazil)

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Keywords:	PRIMARY CARE, PUBLIC HEALTH, EPIDEMIOLOGY

Association between Hospitalization for Ambulatory Care Sensitive Conditions and Primary Health Care physician specialization: a cross-sectional ecological study in Curitiba (Brazil)

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Descriptors: PRIMARY HEALTH CARE, GENERAL PRACTICE, PUBLIC HEALTH, EPIDEMIOLOGY.

ABSTRACT: **Introduction:** Hospitalization for ambulatory care sensitive conditions (HACSCs) is frequently used as an indicator of the quality and effectiveness of primary health care (PHC) services around the world. The aim of the present study was to evaluate whether the PHC model (Family Health Strategy-FHS- x conventional) and the availability of specialized PHC physicians is associated or not with total hospitalization or HACSCs in the National Health System (SUS) of the municipality of Curitiba, Paraná state (PR), Brazil. **Methodology:** this is a cross-sectional ecological study using multiple linear regression with socioeconomic and professional data from Municipal Health Units (MHUs) between April 1, 2014 and March 31, 2015. **Results:** after adjustment for age and sex and control of socioeconomic variables, the FHS model was associated with six fewer HACSCs a year per 10,000 inhabitants in relation to the conventional model and the availability of one Family Physician (FP) at each FHS model MHU per 10,000 inhabitants was associated with 1.1 fewer HACSCs for heart failure (HF) a year per 10,000 inhabitants. Basic Specialists (Clinicians, Pediatricians and Obstetrician/Gynecologists) and Subspecialists showed no significant association with HACSC rates. **Conclusion:** these results obtained in a major Brazilian city reinforce the role of FHS as a priority PHC model in the country and indicate the potentially significant impact of specializing in Family Medicine on improving the health conditions of the population.

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- This study was carried out in an important Brazilian city with high primary health care service coverage where resources are uniformly distributed among health units regardless of their PHC model, allowing reliable analysis of the association between PHC model, medical specialization and hospitalizations for ambulatory care sensitive conditions.
- The socioeconomic and hospitalization data used were obtained from reliable official sources.

- Hospitalizations were adjusted for age, sex and socioeconomic variables, important confounders for the outcomes of interest.
- The short duration of PHC physicians' presence in the MHUs assessed (12 months) and the small number of MHUs studied reduced the power of the study.
- The cross-sectional ecological design is unable to establish a causality relationship between the variables studied.

INTRODUCTION:

Primary health care (PHC) is the first-contact level and the backbone of rational National Health Systems, responsible for providing accessible, continuous, comprehensive and coordinated health care to the population.(1) An important indicator of the quality and effectiveness of this care is the rate of hospitalizations for ambulatory care sensitive conditions (HACSCs).(2-5) These are conditions of needed hospitalization that can be avoided through the provision of timely and qualified PHC services by 1) preventing the onset of disease, 2) adequately controlling acute illness or 3) effectively managing chronic conditions.(6) Brazil has had a National List of Ambulatory Care Sensitive Conditions since 2008.(7,8)

In Brazil, the preferred PHC organization model within the National Health System (SUS) is the Family Health Strategy (FHS).(9) FHS teams consist of a general practitioner, a professional nurse, one or two assistant nurses and 4 to 12 community health agents, caring for 3000 people on average.(9) Nevertheless, the so-called conventional model, based on ambulatory care in the Basic Specialties of Pediatrics, Internal Medicine and Gynecology and Obstetrics persists, particularly in large cities.(10,11) PHC physicians are not legally required to have a specialty. Physicians become specialists in Family Medicine in Brazil after completing two-year Medical Residency program or through a certification examination after 4 years' experience in the field.

Several studies have demonstrated an association between FHS coverage and a decline in HACSCs.(12-15) Between 1999 and 2007, chronic HACSC rates in municipalities with greater FHS coverage were 13% lower in relation to those with less coverage, reaching 23% for hospitalization due to asthma.(16)

A recent study found a significant association between specializing in Family Medicine and the strength of PHC attributes in the FHS of an important Brazilian capital, measured using the PCA-tool.(17) Thus, it can be speculated that specific medical training for PHC in Brazil is

related to both major and intermediate health outcomes. If lower HACSC rates are expected with access to qualified clinical care, medical specialties aimed at training PHC professionals should, in theory, influence this outcome. However, studies that assess the relationship between the specialties of PHC physicians and health outcomes remain scarce.

The aim of the present study was to evaluate whether the PHC model and the availability of specialized PHC physicians are associated or not with total hospitalization or HACSC rates in the National Health System (SUS) of the municipality of Curitiba, Paraná state (PR), Brazil.

METHODOLOGY:

This is a cross-sectional ecological study conducted in the municipality of Curitiba (PR), Brazil. The municipality exhibits high PHC coverage, particularly in terms of FHS, which reached 52% of the population in April 2014.(18) Moreover, a high number of Family Physicians is reported in comparison to other Brazilian capitals, and health care services have been computerized for over a decade.(10) The units of analysis were Municipal Health Units (MHUs), classified as a Family Health Strategy (FHS) or Conventional (EAB) in accordance with the PHC model of their teams.

Data:

Socioeconomic data by census tract were obtained from 2010 Census databases, provided by the Brazilian Institute of Geography and Statistics (IBGE).

Information on hospital admissions was obtained from the Hospital Information System (SIH), through registered Hospitalization Authorization Forms (AIH). Inclusion criteria were single or initial AIH, valid until June 2015, for Curitiba (PR) residents hospitalized in the municipality between April 1, 2014 and March 31, 2015. Hospital admissions for childbirth (International Classification of Diseases, 10th edition - ICD-10 - O.80 to O.84) were excluded as physiological events.(7)

AIH information and socioeconomic data were aggregated at the level of the MHU coverage areas, using QuantumGIS software, version 2.10 Pisa. Addresses on AIH were geocoded using the MMQGIS plugin and GoogleMaps server.

Quantitative data and information on the specialties of PHC physicians in Curitiba (PR) during the study period were obtained from databases of the Curitiba Municipal Health

Department (SMS-Curitiba), Regional Board of Medicine for the State of Paraná, Brazilian Medical Association (AMB), and the National Medical Residency Committee (CNRM).

The MHU model and doctors' working hours were used as predictor variables. Doctors were classified as 1) Family Physicians (FP); 2) Basic Specialty Physicians (BSP); or 3) Subspecialty Physicians (SUBP) if they had concluded their medical residency through the CNRM or been awarded a degree by a scientific association recognized by the AMB prior to May 31, 2015, in the fields of 1) Family Medicine (FM); 2) Internal Medicine, Pediatrics or Gynecology and Obstetrics; and 3) other Medical Specialties, respectively.

The average supply of doctors was calculated using the mean total working hours of physicians in each MHU during the study period. For physicians who remained at the same MHU for the 12-month study period, total effective working hours were added to working hours per category for each MHU, according to the classification above. For each amount, the ratio of working hours to the total population residing in the MHU coverage area (2010 Census) was calculated. In order to facilitate understanding, variables were presented as "Full Time Equivalents", which represent the number of physicians with a 40-hour work week.

As outcome variables for each MHU, total hospitalization rates were calculated, as well as HACSCs and the main ambulatory care sensitive condition per age group, namely bacterial pneumonia (BP) in childhood (0-14 years), angina in adulthood (15-64 years) and heart failure (HF) in the elderly (65 years and older). Hospitalization rates were standardized for age and sex via the direct method, using the structure of the population of Curitiba (PR) according to the 2010 Census as reference. In order to calculate hospitalization rates, the population in the respective MHU coverage areas was used as a denominator, in accordance with the 2010 Census. HACSCs were defined as those for which the "Main Diagnosis" field of the AIH contained a disease classified by an ICD-10 code as belonging to the Brazilian List of Ambulatory Care Sensitive Conditions.(8) Due to its high incidence rate, records for which the main diagnosis was ICD-10 J18.9 (Pneumonia; unspecified organism) were included in this study as BP.

Four socioeconomic variables relevant to the studied outcomes were adopted as context per MHU: 1) literacy rate in the population aged 10 years or older (Lit.Rt); 2) percentage of blacks, mulattos and native Brazilians (Pop.Perc); 3) Per capita income (Income); and 4) percentage of households with a per capita income below half the minimum wage (Perc.House).

Data analysis:

SPSS Statistics software version 18 (PASW Statistics 18) was used for data analysis. Calculation of the variance inflation factor (VIF) identified high collinearity (VIF>5) between the socioeconomic variables Lit.Rt, Pop.Perc and Perc.House, preventing their concomitant use in the analysis, but not between variables related to physician working hours. Working hours per medical category were similar between EAB and FHS model MHUs, except for FP, whose working hours were 15 times higher at FHS model MHUs than conventional (EAB) units.

In order to estimate the effects of predictor variables independently of socioeconomic variables, hierarchical linear regression with stepwise-backward elimination was carried out for each dependent variable studied, with an F-to-enter statistic of 0.10 and F-to-remove of 0.20, initially for all the MHUs and subsequently for FHS model MHUs. The variable related to the FP category was only used in the latter given its significant association with this model.

Two models were constructed. Model 1 included the variable "Income" and, among the socioeconomic variables exhibiting high collinearity, the variable with the greatest Beta value in simple regression for the dependent variable under study. Variables with a p-value lower than 0.20 were maintained and fixed for model 2, which included the other variables under study. The results were presented as non-standardized coefficients and considered significant at 5%. Results significant at 10% were identified for HACSCs.

RESULTS:

The study included 109 MHUs, 44 (40.4%) of which were conventional (EAB) and 65 (59.6%) applied the FHS model. Of the FHS model MHUs, one (0.9%) was created during the study period. In April 2015, SMS-Curitiba had 512 PHC physicians, 433 of which remained at the same MHU throughout the 12-month study period. Seventy-seven (17.8%) were classified as FP; 117 (27.0%) as BSP; 37 (8.5%) as SUBP, and 202 (46.7%) had no specialty recognized by the CNRM or AMB.

Figure 1 shows the selection of AIH for analysis according to inclusion and exclusion criteria. The mean values of each variable studied are shown in Table 1, accompanied by standard deviation.

Figure 1. Selection of AIH for analysis according to inclusion and exclusion criteria.

Table 1. Means and standard deviations for socioeconomic variables, hospitalization rates, and full time equivalents according to MHU models. Curitiba (PR), Brazil.

Study variables	EAB (n=44 MHUs)		FHS (n=65 MHUs)		Total (n=109 MHUs)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Socioeconomic variables						
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	98.4	0.7	96.8	1.4	97.4	1.4
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	16.8	5.4	27.6	8.2	23.2	8.9
Per capita income (R$) – Income	1,232.57	493.16	777.17	429.07	961.00	506.28
Percentage of households with a per capita income below minimum wage (%) – Perc.House	6.0	2.6	12.6	5.8	10.0	5.8
Hospitalization rates per year per 10,000 inhabitants						
Total	418.7	127.9	499.4	154.0	466.8	148.9
HACSCs	46.0	13.7	47.7	14.2	47.0	14.0
Bacterial Pneumonia - BP	11.8	5.9	12.9	6.2	12.5	6.1
Angina	8.2	3.2	8.3	4.2	8.3	3.9
Heart Failure - HF	8.0	2.9	7.7	3.2	7.8	3.1
Full time equivalents per 10,000 inhabitants.						
Average supply	2.10	0.76	3.51	1.50	2.94	1.43
Family Physician - FP	0.06	0.12	0.89	1.10	0.55	0.95
Basic Specialists (Clinicians, Pediatrics and Gynecologists) - BSP	0.75	0.47	0.21	0.40	0.43	0.50
Subspecialty Physicians - SUBP	0.17	0.20	0.19	0.50	0.18	0.40
Physicians at the same MHU for 12 months - Total	1.77	0.73	2.58	1.28	2.25	1.16

The coverage areas of FHS model MHUs exhibited worse socioeconomic conditions compared to EAB units. Among FHS model MHUs, a negative association was observed between Equivalent FP and the variables Lit.Rt and Income. The same was true for the variables Total Equivalent and SUBP Equivalent, while the opposite was observed for the group BSP Equivalent.

The results of hierarchical linear regression coefficients in models 1 and 2 are presented in Tables 2 and 3, respectively. Values statistically significant at 5% are identified in the tables. For HACSCs, results statistically significant at 10% are also marked.

Socioeconomic variables were alternately significant for all the dependent variables when all the MHUs were analyzed, except for angina-related HACSCs, indicating that the better the socioeconomic conditions, the lower the hospitalization rates. In analysis of FHS model MHUs, only the association between the Lit.Rt and hospitalization rates for BP was statistically significant at 5%.

The FHS model was associated with fewer HACSCs (on average 6.0 fewer hospitalizations a year per 10,000 inhabitants in relation to the EAB model), statistically significant at 5%. A statistically significant association was also observed between the availability of FP and fewer HACSCs for HF in FHS model MHUs (1.1 fewer hospitalizations a year per 10,000 inhabitants for every 40-hour week FP per 10,000 inhabitants). The variable Total equivalent was significantly correlated with higher HACSC rates in all the MHUs, as well as higher total hospitalization rates and admissions due to ambulatory care sensitive conditions in FHS model MHUs. The variables Average Supply Equivalent, BSP Equivalent and SUBP Equivalent were not significantly associated with any of the outcomes studied.

Table 2. Results of hospitalization coefficients and p-values for model 1 of the socioeconomic variable for all MHUs and FHS model MHUs. Curitiba (PR), Brazil.

Socioeconomic variables	Total		HACSCs		Heart Failure - HF		Angina		Bacterial Pneumonia - BP	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Total (n=109 MHUs)										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-55.0[a].**	**<0.001**	*	*	-0.1	0.861	-0.1	0.801	**-1.7[a]**	**<0.001**
Per capita income (R$ 100.00) – Income	*-5.2[b]*	*0.129*	**-1.2[a]**	**<0.001**	**-0.2[a]**	**0.007**	-0.1	0.347	-0.1	0.382
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	0.2	0.504	*	*	*	*	*	*
FHS model MHUs (n=64)										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-42.5[a]**	**0.001**	**-3.4[a]**	**0.006**	*-0.5[b]*	*0.059*	*	*	**-1.7[a]**	**0.002**
Per capita income (R$ 100.00) – Income	2.2	0.688	-0.4	0.440	-0.1	0.784	-0.1	0.804	0.1	0.535
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	-0.1	0.480	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*

[a] Value p<0.05. [b] Value p<0.20.

Table 3. Results of hospitalization coefficients and p-values for model 2 of the socioeconomic variables, full time equivalents and PHC model for all MHUs and FHS model MHUs. Curitiba (PR), Brazil.

Variables	Total		HACSCs		Heart Failure - HF		Angina		Bacterial Pneumonia - BP	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Total (n=109 MHUs)										
Socioeconomic variables										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	**-32.5**[a]	**0.015**	*	*	*	*	*	*	**-2.1**[a]	**0.000**
Per capita income (R$ 100.00) – Income	-4.9	0.151	**-1.2**[a]	**0.000**	**-0.2**[a]	**0.001**	*	*	*	*
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*
Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*
Full time equivalents per 10,000 inhabitants.										
Average supply	-25.8	0.187	-2.0	0.260	-0.5	0.226	-0.6	0.224	-0.8	0.367
Basic Specialists (Clinicians, Pediatrics and Gynecologists) - BSP	-7.5	0.811	-2.7	0.361	0.1	0.920	-0.7	0.427	-1.3	0.334
Subspecialty Physicians - SUBP	14.2	0.644	2,2	0.465	-0.1	0.908	-0.4	0.673	-0.5	0.697
Physicians at the same MHU for 12 months - Total	*22.1*[c]	*0.080*	**2.6**[a]	**0.023**	0.4	0.152	0.4	0.172	0.7	0.201
PHC Model										
PHC Model (EAB=0, FHS=1)	-13.1	0.665	**-6.0**[a]**.**	**0.030**	*-1.2*[c]	*0.062*	-0.3	0.761	*-2.3*[c]	*0.078*
FHS model MHUs (n=64)										
Socioeconomic variables										
Literacy rate in the population aged 10 years or older (%) – Lit.Rt	-23.8	0.104	*-2.3*[c]	*0.088*	-0.4	0.203	*	*	**-1.7**[a]	**0.002**
Per capita income (R$ 100.00) – Income	*	*	*	*	*	*	*	*	*	*
Percentage of households with a per capita income below minimum wage (%) – Perc.House	*	*	*	*	*	*	*	*	*	*

Percentage of blacks, mulattos and native Brazilians (%) – Pop. Perc	*	*	*	*	*	*	*	*	*	*
Full time equivalents per 10,000 inhabitants.										
Average supply	-9.6	0.720	-2.7	0.289	-0.2	0.736	-0.9	0.136	-0.8	0.402
Family Physician - FP	*-38.6* [c]	*0.057*	*-3.2* [c]	*0.091*	**-1.1** [a]	**0.016**	0.7	0.243	-0.1	0.959
Basic Specialists (Clinicians, Pediatrics and Gynecologists) - BSP	*-87.0* [c]	*0.070*	-6.4	0.157	-0.5	0.613	-0.7	0.636	-2.6	0.170
Subspecialty Physicians - SUBP	-0.2	0.997	0.3	0.937	-0.7	0.379	0.3	0.787	-0.1	0.994
Physicians at the same MHU for 12 months - Total	**51.2**[a]**.**	**0.012**	**4.0** [a]	**0.026**	*0.8* [c]	*0.060*	0.5	0.251	1.0	0.107

[a] Value p<0.05. [c] Value p<0.10.

Some results were only statistically significant at 10%, as follows: 1) FHS model and lower HACSC rates for HF and BP; 2) FP Equivalent and lower total hospitalization and HACSC rates in FHS model MHUs; 3) BSP Equivalent and lower total hospitalization rate in FHS model MHUs; 4) Total Equivalent and higher total hospitalization rate in total MHUs and higher HACSC rates for HF under the FHS model; and 5) Lit.Rt and lower HACSC rates under the FHS model.

DISCUSSION:

In the present study, after adjustment for age and sex and control of socioeconomic variables, lower HACSC rates were significantly associated with the FHS model and the presence of FP in the municipality of Curitiba (PR), Brazil. No significant associations were observed between HACSCs and other medical specialties, while worse results were found for the total number of doctors present over the 12-month study.

The association between the FHS model and low HACSC rates is consistent with other studies.(12,13,15) Although Curitiba exhibited one of the lowest HACSC rates among Brazilian capitals, the difference between the models (FHS and EAB) was equivalent to 13% of the municipality's HACSCs for the period. The FHS model was also correlated with fewer hospitalizations for HF and BP, both statistically significant at 10%. These results reinforce the knowledge accumulated in the literature, which justify maintaining, expanding and consolidating this strategy in the country, even in socially and economically developed municipalities such as Curitiba.

Among the FHS model units, the presence of FP was significantly associated with lower hospitalization rates for HF, the main cause of HACSCs in the elderly population of Curitiba during the study period. The presence of one 40-hour work week FP per 10,000 inhabitants was related to 14% fewer hospitalizations for this condition in the municipality. This suggests that the presence of these professionals could have a potentially significant impact on the country, since HF is also the main cause of HACSCs in Brazil.(19)

FP were also significantly associated with the total hospitalization and overall HACSC rates. Although results were significant at 10% but not 5%, the association was clinically significant. For every 40-hour work week physician per 10,000 inhabitants, there were 3.2 fewer HACSCs a year per 10,000 inhabitants. Considering the recommendation of the 2012 National Primary Care Policy that each FHS team should cover an average of 3,000 people, based on the results found, one would expect a reduction of 9.6 HACSCs a year per 10,000 inhabitants, if 3 FP are present in comparison to 3 physicians without this specialty.(9) This could represent a more than 20% drop in the average for the municipality, regardless of other factors.

Despite being associated with the PHC model at 10% significance, hospitalization for BP, the main cause of HACSCs among children (0-14 years), did not appear to be related to the presence of FP in this study. This can be explained by the fact that BP is an acute condition, unlike HF. Considering the essential attributes of PHC, the literature indicates a strong overall relationship between access and HACSCs.(20-22) In terms of longitudinal care/continuity, studies have found an inverse association with only chronic ambulatory care sensitive conditions.(23,24) Thus, it can be concluded that the access provided by MHUs is more relevant when treating BP, which is less influenced by FM specialty. On the other hand, in cases of HF, both access and qualified longitudinal care are essential to achieve fewer hospitalizations.

Hospitalizations for angina, the main cause of HACSC in the 15 to 64-year age group, were not associated with any variables, whether socioeconomic or health service-related. The short study period of 12 months may explain this finding. Moreover, this condition typically develops over decades and is heavily influenced by risk factors related to the individual's lifestyle. Although angina is considered an ambulatory care sensitive condition, the extent to which health care services can modify its progression is debatable.

Basic Specialists at the same MHU for the 12-month study period were associated to lower total hospitalization rate in FHS model MHUs at 10% significance, but not

to lower HACSC rates, which suggests it is a spurious association. Subspecialists at the same MHU for the 12-month study period were not significantly related to any of the dependent variables. This finding suggests that FM is superior to other specialties in PHC settings in terms of reducing HACSCs. Contrary to the findings of other studies, the average supply of doctors in the study period was not associated with any of the dependent variables assessed.(20,22) This may be due to the adequate supply of physicians in terms of the municipality's needs. Unexpectedly, the total number of doctors at the same MHU throughout the 12-month study, almost half of whom were not registered as specialists on official databases, was significantly related to worse hospitalization rates for some conditions. Although certain limitations of this study may explain some of these findings, the results strongly suggest that medical specialties in PHC may play an important role in care quality and the impact of outcomes on health, whether positive or negative.

This study includes data from all public admissions to hospitals in Curitiba and all municipal health units, thereby covering the entire public healthcare system. As such, it reliably represents the specific scenario of Curitiba. It is conceivable that other large Brazilian cities with structured PHC coverage, such as Florianopolis and Belo Horizonte, would obtain similar results. Nevertheless, the associations found in this study should be confirmed by further research in these cities, in addition to testing whether they are also present in other scenarios, such as low PHC coverage.

Limitations:

With respect to the limitations, the first is inherent to the study design; as such, it cannot be concluded that the findings presented here on an ecological level necessarily reflect associations on an individual level. However, the hypothesis that both the PHC model and the medical specialty best suited to primary care can reduce HACSCs, one of the main indicators used to assess the quality of PHC, seems plausible.

The study period was too short to properly analyze the outcomes. A study of elderly individuals in the United States suggested a minimum doctor-patient relationship of 5 to 10 years was needed to obtain a significant variation in the hospitalization rates of these patients.(25) However, the high turnover rate of PHC physicians in Brazil combined with the difficulty in collecting older data on municipal health services made it impossible to lengthen the study period.

The small number of MHUs studied (109 MHUs in total and 65 FHS model MHUs) compromised the statistical power and may explain the scarcity of statistically significant results at 5% significance. As such, we also applied a 10% significance level for associations initially non-significant at 5% so as not to neglect clinically meaningful results

Some confounding factors potentially relevant to the outcomes studied were not explored here. These include characteristics of the multidisciplinary team, involvement with teaching activities, when professionals and teams began working in the area, presence of other social resources in the area and the existence of geographic or socio-organizational barriers to access.

Finally, there are two other noteworthy limitations. The study used population data from the 2010 Census, whereas hospitalization data were from April 2014 to March 2015. In addition, hospitalization data were obtained from AIH, a hospital reimbursement tool used exclusively in the public health system with no information on private admissions (funded by health care plans, health insurance or individuals). However, Curitiba has shown little population change, with growth estimated at only 7% between 2010 and 2015. This growth is not homogeneous across the municipality and areas with unfavorable socioeconomic conditions show the greatest expansion.(26,27) As such, hospitalization rates for the most vulnerable regions of Curitiba may have been overestimated in relation to other areas in this study, owing to underestimation of its population in 2015, whose growth potential would have been greater between 2010 and 2015, and non-notification of private hospital admissions in wealthier areas. This did not prevent findings of better outcomes associated with the FHS model and the Family Medicine specialty, but may explain the absence and/or fragility of other associations observed as well as the worse outcomes related to the total number of doctors at the same MHU for 12 months.

CONCLUSION:

Based on hospitalization rates adjusted for age and sex and controlled analysis of socioeconomic factors whose influence on hospitalization is recognized in the literature, the FHS model was significantly associated with lower HACSC rates and the availability of FP was significantly correlated with lower HACSC rates due to HF in Curitiba (PR), Brazil, from April 2014 to March 2015.

The fact that the best outcomes recorded in a major Brazilian municipality known for its well organized health system were associated with the FHS model reinforces FHS as the

preferred organization model for PHC in Brazil. On the other hand, the statistically significant association between the presence of FP and lower HF rates, the leading cause of HACSCs among the elderly in Curitiba, may be an effective means of reducing financial costs and human suffering, since the aging of the Brazilian population suggest a current and future increase in chronic disease.

It is important to underscore that Basic Specialties, as well as those in other medical fields (called Subspecialties) were not significantly associated with any HACSC rates studied. Finally, the association between the total number of doctors at the same MHU for the 12-month study period, almost half of whom were not specialists, and higher hospitalization rates calls for urgent reflection on the possibility of iatrogenesis in PHC and the need to implement mandatory medical specialties after the completion of undergraduate medical courses, as occurs in several first world countries. The findings of this study should be confirmed by further in-depth assessments that eliminate or minimize the limitations presented.

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FOOTNOTES

- **Contributors** MPDA conceived the study. MPDA, HES, EMH and WMR designed the study. MPDA collected and organized data. MPDA, HES, EMH, WMR and TA analyzed data. MPDA drafted the manuscript. All the authors revised the article and agreed with the final version and findings.
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- **Competing interests** MPDA served as vice president for the Family Medicine Association of Brasilia (ABrMFC) Board of Directors from 2014 to 2015. ABrMFC is a non-profit professional and scientific regional association, affiliated with the Brazilian Family Medicine Society (SBMFC).

- **Ethics approval** This study was approved by the Research Ethics Committees of the Coordinating (FS/UnB, CAAE 42275414.0.0000.0030) and Partner Institutions (SMS-Curitiba, CAAE 42275414.0.3001.0101).
- **Provenance and peer review** Not commissioned.
- **Data sharing statement** The hospitalization rates, socioeconomic indicators and medical workload per MHU have not been published and are available by emailing MPDA.

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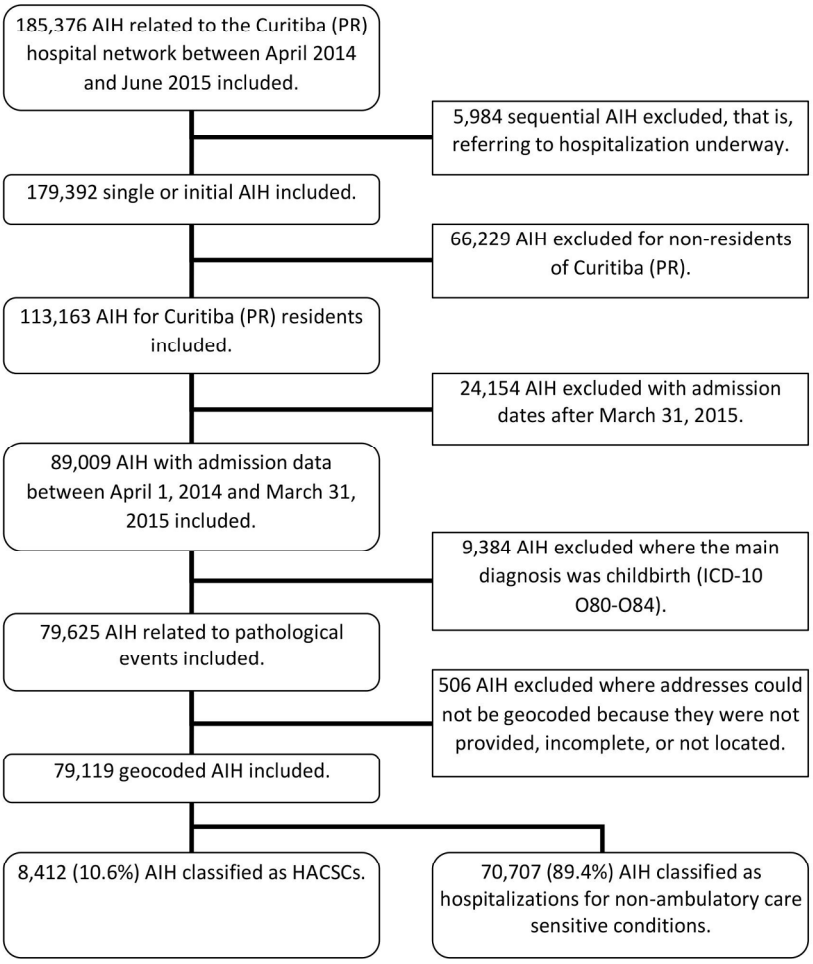

Figure 1. Selection of AIH for analysis according to inclusion and exclusion criteria.

177x202mm (300 x 300 DPI)

Title: Association between Hospitalization for Ambulatory Care Sensitive Conditions and Primary Health Care physician specialization: a cross-sectional ecological study in Curitiba (Brazil)

Authors: AFONSO, MPD; SHIMIZU, HE; MERCHAN-HAMANN, E; RAMALHO, WM; AFONSO, T

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Included (page)
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	**YES (p. 1)**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	**YES (p. 1)**
Introduction			
Background / rationale	2	Explain the scientific background and rationale for the investigation being reported	**YES (p. 2-3)**
Objectives	3	State specific objectives, including any prespecified hypotheses	**YES (p. 3)**
Methods			
Study design	4	Present key elements of study design early in the paper	**YES (p. 3)**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	**YES (p.3-4)**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	**YES (p. 3-4)**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	**YES (p.4)**
Data sources / measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	**YES (p. 3-4)**
Bias	9	Describe any efforts to address potential sources of bias	**YES (p. 3)**
Study size	10	Explain how the study size was arrived at	**YES (p. 3-4)**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	**YES (p. 4)**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	**YES (p. 5)**
		(*b*) Describe any methods used to examine subgroups and interactions	**YES (p. 5)**
		(*c*) Explain how missing data were addressed	**YES (p. 6)**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	**N.A.**
		(*e*) Describe any sensitivity analyses	**N.A.**
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	**YES (p. 5-6)**
		(b) Give reasons for non-participation at each stage	**YES (p. 6)**
		(c) Consider use of a flow diagram	**YES (p. 6)**

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	**YES (p. 7)**
		(b) Indicate number of participants with missing data for each variable of interest	**N.A.**
Outcome data	15*	Report numbers of outcome events or summary measures	**YES (p. 7)**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	**YES (p. 9-11)**
		(*b*) Report category boundaries when continuous variables were categorized	**N.A.**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	**YES (p. 8)**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	**N.A.**
Discussion			
Key results	18	Summarise key results with reference to study objectives	**YES (p. 11)**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	**YES (p. 13-14)**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	**YES (p.11-15)**
Generalisability	21	Discuss the generalisability (external validity) of the study results	**YES (p. 13)**
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	**YES (p. 15)**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.